Attachment 7

Stormwater Flood Management Grant Proposal
City of Redwood City
Economic Analysis - Flood Damage Reduction Costs and Benefits

Attachment 7 consists of the following items:

- ✓ **Flood Damage Reduction Costs and Benefits.** Attachment 7 provides estimates for the flood damage reduction benefits of the proposed project.
- ✓ **Appendix 7-1.** Appendix 7-1 of this attachment contains detailed information and background regarding the qualitative and quantitative costs and benefits for the proposed project.

Introduction

This attachment provides estimates for flood damage reduction costs and benefits. Where possible, each benefit was quantified and presented in physical or economic terms. In cases where quantitative analyses were not feasible, this attachment provides complimentary qualitative analyses. In addition, this attachment provides a description of economic factors that may affect or qualify the amount of economic benefits to be realized. This attachment also includes a discussion regarding uncertainties about the future that might affect the level of benefit received. Appendix 7-1 contains detailed information regarding the benefits anticipate to occur as a result of this proposed project.

Project Costs

The total estimated budget for the proposed project is $16,000,000 (refer to Attachment 4). Operations, maintenance, and replacement costs are anticipated throughout the project lifetime, in order to maintain the pump station. Operation and maintenance costs assume one crew member at approximately 3 hours per week with a loaded rate of $125/hour. Replacement costs were estimated to be 5% of equipment cost every 2 years after the pump station reaches five years of age. These additional costs are approximately $25,500 annually and total $1,137,300 for the project. This results in a total present value of $12,715,552 (in 2009 dollars).

Capital and implementation costs for the project will be expended from 2011 through 2015, with the largest capital costs in construction and implementation. The operation and maintenance costs are estimated to consist of operation, maintenance, and replacement costs. Operation and maintenance costs will span from 2016 through 2060, and replacement costs will be incurred from 2028 through 2060. Detailed cost information associated with the project, including present value calculations, are available in Appendix 7-1.

Table 7-1: Total Project Costs

Phase	Cost
Capital Costs	$16,000,000
O&M and Replacement Costs	$1,137,300
Total Project Costs	$17,137,300
Total Present Value of Discounted Costs ($2009)	**$12,715,552**

Flood Damage Reduction Benefits

The benefits that are anticipated to result from implementation of the proposed project are summarized below in Table 7-2, and the cost-benefit overview is summarized in Table 7-3. This project would result in monetized benefits due to avoided flood damages. Detailed cost and benefit information associated with the project, including present value calculations, are available in Appendix 7-1.

Table 7-2: Benefits Summary

Type of Benefit	Assessment Level	Beneficiaries
Flood Damage Reduction Benefits		
Avoided Flood Damages	Monetized	Local

Table 7-3: Benefits-Cost Analysis Overview

	Present Value ($2009)
Costs – Total Capital and O&M	$12,715,552
Monetizable Benefits	
Avoided Flood Damages	$14,217,595

*Magnitude of effect on net benefits
+/- (negligible or unknown); + (moderate); ++ (significant positive): - (moderate negative); -- (significant negative)

The "Without Project" Baseline

If the proposed project were not implemented, there would no flood hazard reductions within the Bayfront Canal. As a result, the surrounding basins would continue to flood on a regular basis, putting a strain on public resources, including public works, fire and safety.

Flood Damage Reduction Benefits

Avoided Flood Damages

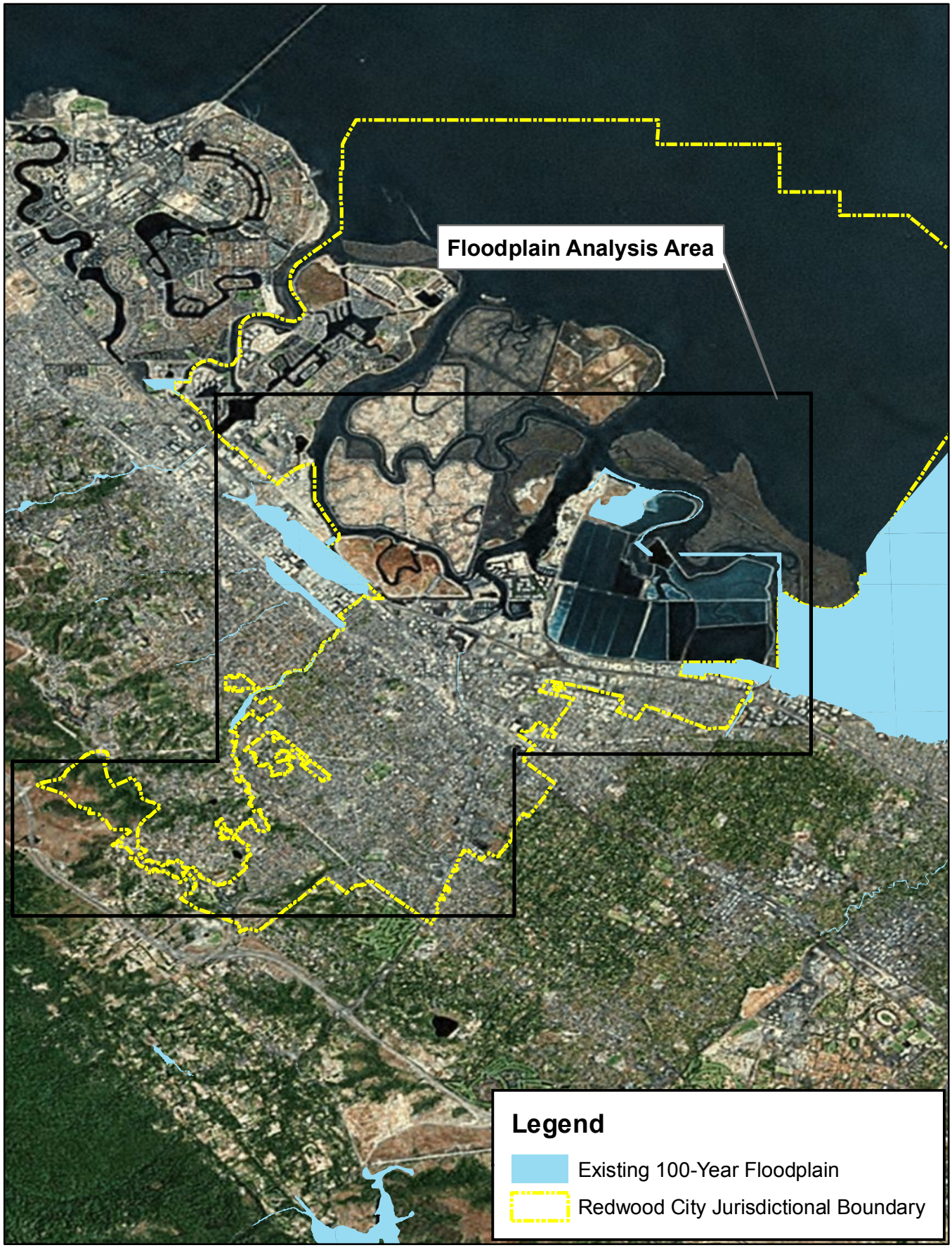
The proposed project would upsize the 5th Avenue Pump Station to handle increased flow and would construct infrastructure improvements to the local drainage system along the Bayfront Canal. Once upsizing and construction has occurred, these improvements would manage flows associated with a 100-year storm event, thus eliminating flood flows reaching the City of Redwood City, the City of Menlo Park, parts of the Town of Atherton and unincorporated regions of San Mateo County. In addition, once upsizing and construction has occurred, these improvements would reduce flooding frequency for properties within the floodplain.

For purposes of this Stormwater Flood Management Grant, additional economic benefit research was conducted using hydraulic modeling along with the Flood Rapid Assessment Model (FRAM) developed for DWR, and the Benefit Cost Analysis software developed by FEMA.

As a result of the proposed project, damages associated with storm events would cease to occur since the upsized pump station will be able to handle the flows associated with these events. To estimate the flood damage reduction benefits associated with storm events, data for a 25-year storm event and a 100-year storm event was evaluated. Utilizing engineering reports and FEMA Floodplain Maps, the number of parcels and the length of road were estimated within the floodplains associated with each flood event. The 100-year floodplain associated with this project area is shown in Figure 1. As a result the following were identified within the 100-year flood plain:

- Residential Structures: 156
- Commercial Structures: 269
- Length of arterial roads: 16 miles
- Length of major roads: 9 miles
- Length of minor roads: 68 miles

Figure 1: Existing FEMA 100-Year Floodplain



The 25-year floodplain was not available from FEMA, but topography and storm event information and associated flow conveyance into the canal was estimated in a study of the local drainage system (Bayfront Canal Improvement Project, Winzler & Kelly, 2003). The study found that the Bayfront Canal area in general is composed of flat land parcels situated between the canal and Highway 101. The study also found that total peak flows associated with the conveyance of water to the canal were estimated for the 25-year and 100-year storm events:

- 25-year storm: 1319 cubic feet per second
- 100-year storm: 1665 cubic feet per second

Based on the flow information and the topography of the surrounding area, it was estimated that the number of residential structures and the length of road within the 25-year floodplain was a function of the volumetric flow into the canal. Therefore, these values were estimated by multiplying the numbers for the 100-year event by the ratio of the volumetric flow for the 25-year event and 100-year event. As a result, the estimated number of parcels and the length of road in the flood inundation zone associated with a 25-year storm event were:

- Residential Structures: 123
- Commercial Structures: 212
- Length of arterial roads: 12.64 miles
- Length of major roads: 7.11 miles
- Length of minor roads: 53.72 miles

Damage associated with the length of road is estimated using FRAM, which already has algorithms to estimate the avoided flood damage benefits for roads. For the residential and commercial structures, the economic information that was input into FRAM along with the flood inundation data was determined from the National Flood Insurance Program (NFIP). NFIP states that over the past ten years, the average flood claim has amounted to over $33,000 (NFIP, 2011). For purposes of this analysis, It was assumed that each commercial structure that would be impacted would have an average claim of $33,000. For residential structures, the average home in Redwood City is 1,400 square feet, based on assessor data. NFIP estimates the cost of flooding for 1,000 square foot homes and 2,000 square foot homes. For purposes of this analysis, the NFIP estimate for the average cost of flooding associated with a 1,000 square foot home with 1 inch of flooding was used; this value is $10,600 per home.

As per requirements set forth by DWR, the project is assumed to have a 50-year lifetime. Therefore, the present value coefficient utilized for these calculations was 15.76, which assumes a 50 year benefit period. The estimated monetary benefits that would result from the aforementioned avoided flood damages would be $908,471 annually, for a present value of $14,217,595 ($2009).

Table 7-4: Avoided Flood Damages

	Event Damage Without Project	Event Damage With Project	Total Avoided Costs
Expected Annual Damage	$908,471	$0	$908,471
Present Value of Future Avoided Damage Benefits after Discounting ($2009)			**$14,217,595**

Detailed avoided flood damages associated with the project are available in Appendix 7-1.

Distribution of Project Benefits and Identification of Beneficiaries

Table 7-5 summarizes the anticipated beneficiaries of flood damage reduction benefits that would be provided by the proposed project. The flood damage reduction benefits would benefit local residents and businesses within the floodplain associated with the project area.

Table 7-5: Project Beneficiaries Summary

Local	Regional	Statewide
Local residents and businesses within the floodplain	Regional residents and businesses within the floodplain	Not Applicable

Project Benefits Timeline Description

Flood reduction benefits would occur over a timeline relative to the probability of various hydrologic events. Therefore, this project would accrue avoided flood damage benefits due to 25-year and 100-year storm events.

Potential Adverse Effects from the Project

Any potential short-term impacts associated with this project will be addressed and mitigated during the CEQA compliance process. No long-term adverse effects are expected as a result of this project.

Uncertainty of Benefits

Uncertainties relating to the flood reduction benefits of this project are summarized below in Table 7-6. As shown in the table below, uncertainties regarding flood reduction benefits would occur because additional detailed flood modeling of floodplains associated with pump station operation and infrastructure improvements are needed.

Table 7-6: Omissions, Biases, and Uncertainties and their Effect on the Project

Benefit or Cost Category	Likely Impact on Net Benefits	Comment
Flood Damages Reduction Costs	+	Benefit is likely to have a moderate positive benefit on private (residences and commercial businesses) and municipal (roads and storm drain systems) property. Detailed flood modeling to augment the information provided by floodplain maps and the FRAM model needs to be performed.

*Magnitude of effect on net benefits
+/- (negligible or unknown); + (moderate); ++ (significant positive): - (moderate negative); -- (significant negative)

Appendix 7-1: Economic Analysis Tables

Table 10 - Annual Cost of Flood Damage Reduction Project
(All costs should be in 2009 dollars)
Project: Bayfront Regional Drainage System Improvements and 5th Avenue Pump Station Renovation Project

	Initial Costs	Operations and Maintenance Costs						Discounting Calculations	
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Year	Capital and Other Initial Costs from Table 6	Admin	Operation	Maintenance	Replacement	Other	Total Costs (a)+…+(f)	Discount Factor	Discounted Costs (g) x (h)
2009	$0	$0	$0	$0	$0	$0	$0	1.00	$0
2010	$0	$0	$0	$0	$0	$0	$0	0.94	$0
2011	$1,000,000	$0	$0	$0	$0	$0	$1,000,000	0.89	$889,996
2012	$2,500,000	$0	$0	$0	$0	$0	$2,500,000	0.84	$2,099,048
2013	$5,000,000	$0	$0	$0	$0	$0	$5,000,000	0.79	$3,960,468
2014	$5,000,000	$0	$0	$0	$0	$0	$5,000,000	0.75	$3,736,291
2015	$2,500,000	$0	$0	$0	$0	$0	$2,500,000	0.70	$1,762,401
2016	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.67	$13,301
2017	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.63	$12,548
2018	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.59	$11,838
2019	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.56	$11,168
2020	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.53	$16,488
2021	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.50	$9,939
2022	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.47	$14,675
2023	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.44	$8,846
2024	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.42	$13,060
2025	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.39	$7,873
2026	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.37	$11,624
2027	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.35	$7,007
2028	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.33	$10,345
2029	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.31	$6,236
2030	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.29	$9,207
2031	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.28	$5,550
2032	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.26	$8,194
2033	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.25	$4,940
2034	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.23	$7,293
2035	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.22	$4,396
2036	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.21	$6,491
2037	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.20	$3,913
2038	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.18	$5,777
2039	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.17	$3,482
2040	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.16	$5,141
2041	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.15	$3,099
2042	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.15	$4,576
2043	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.14	$2,758
2044	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.13	$4,072
2045	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.12	$2,455
2046	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.12	$3,624
2047	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.11	$2,185
2048	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.10	$3,226
2049	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.10	$1,944
2050	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.09	$2,871
2051	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.09	$1,731
2052	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.08	$2,555
2053	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.08	$1,540
2054	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.07	$2,274
2055	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.07	$1,371
2056	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.06	$2,024
2057	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.06	$1,220
2058	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.06	$1,801
2059	$0	$0	$10,000	$10,000	$0	$0	$20,000	0.05	$1,086
2060	$0	$0	$10,000	$10,000	$11,300	$0	$31,300	0.05	$1,603
TOTALS	**$16,000,000**	**$0**	**$450,000**	**$450,000**	**$237,300**	**$0**	**$17,137,300**	**$17**	**$12,715,552**
Project Life							Total Present Value of Discounted Costs (Sum of Column (i)) Transfer to Table 20, Column (c), Exhibit F: Proposal Costs and Benefit Summaries		**$12,715,552**

Comments: O&M assumes 3 hrs/week at $125 per hour = approx. $20,000 per year. Replacement assumes 5% of equipment construction cost of pump station every other year starting year 5 = $11,300 . Assume sheet piles do not have replacement costs.

Table 12 - Present Value of Expected Annual Damage Benefits (2009 dollars) Project: Bayfront Regional Drainage System Improvements and 5th Avenue Pump Station Renovation Project			
(a)	Expected Annual Damage Without Project		**$908,471**
(b)	Expected Annual Damage With Project		**$0**
(c)	Expected Annual Damage Benefit	[a - b]	**$908,471**
(d)	Present Value Coefficent		**15.65**
(e)	**Present Value of Future Benefits**	**[c x d]**	**$14,217,595**
Comments: Used FRAM model to estimate damage to buildings and roads.			